# Project Final Report

**A Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed**
**15-04/319**

Dates: 2015-2017

Franklin Regional Council of Governments

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PREPARED FOR:

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER RESOURCES

AND

US ENVIRONMENTAL PROTECTION AGENCY
REGION 1

MASSACHUSETTS EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
Matthew A. Beaton, Secretary

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Martin Suuberg, Commissioner

BUREAU OF WATER RESOURCES
Douglas Fine, Assistant Commissioner

DIVISION OF MUNICIPAL SERVICES
Steven J. McCurdy, Director

## A. Project Snapshot

Project Number and Title: 15-04/319. A Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed

A1. Project start date: May 28, 2015

A2. Date closed: June 30, 2017

A3. Basin and HUC 12 subwatershed: Deerfield Basin; HUC 12 subwatersheds: East Branch North River; North River mainstem; Green River- Thorne Brook to mouth; Deerfield River-Cold River to North River; Deerfield mainstem- North River to mouth; Clesson Brook; Deerfield River - Sherman Dam to Cold River; Cold River; South River and Chickley River

A4. Segment and/or waterbody number(s):

| Name/Segment | Category 5 requires TMDL | Cause of Impairment | Approximate Length of River Segment |
|---|---|---|---|
| Chickley River/MA33-11 | ✓ | Fecal Coliform | 11 miles |
| Davis Mine Brook/MA33-18 | ✓ | pH, Low | 3 miles |
| Green River/MA33-30 | ✓ | Fecal Coliform | 4 miles |
| South River/MA33-08 | ✓ | Fecal Coliform; Physical substrate habitat alterations. | 13 miles |

A5. Status of waterbody (Category 5, etc.): see above.

A6. Priority Pollutant(s) targeted: Healthy Watersheds; sediment, nutrients, bacteria

A7. Estimated annual pollutant removal (quantity, not percentage) and method of determination and calculations: This was a Healthy Watersheds project. A pollution loading model was used as a screening tool to focus field work and the development of recommendations. No implementation projects were completed as part of this project.

A8. BMPs installed, number and type: None. See above.

## Descriptive Project Summary

## MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

## SECTION 319 NPS PROJECT 15-04/319

PROJECT TITLE: A Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed
NPS CATEGORY: Healthy Watersheds
INVESTIGATOR: Franklin Regional Council of Governments
LOCATION: Deerfield River Watershed

DESCRIPTION: The Deerfield River Watershed contains high quality water resources and large blocks of contiguous habitat. The development and implementation of a comprehensive watershed management plan will protect the high water quality of the Watershed, increase its resiliency to climate change, and restore the water quality and degraded fluvial geomorphic and habitat functions of impaired areas of the watershed.

PROJECT GOALS: Develop a comprehensive Watershed-Based Plan for the Watershed that integrates the statewide Watershed-Based Plan strategy, the EPA's Healthy Watersheds Initiative, and climate change adaptation strategies. The plan will characterize the watershed conditions, identify, investigate, and address the current and emerging issues facing the watershed, and include specific, measurable actions to protect and improve water resource conditions and climate change resiliency. It will result in on-the-ground change within the watershed by recommending specific, measurable actions to protect and improve water resource conditions, and will proceed simultaneously with the development of the statewide strategy and may be amended accordingly.

PROJECT TASKS INCLUDE:
1: Quality Assurance and Project Evaluation
2: Build Partnerships
3: Compile Baseline Watershed Conditions Data [Element A of a Watershed-Based Plan]
4: Issue Request for Responses for Consultant Services for Tasks 5, 6, and 7
5: Estimate Pollutant Loads [Element A]
6: Comparative Subwatershed Analysis
7: Watershed Field Inventories [Elements A and C]
8: Land Use Regulatory Review [Element C]
9: Green Infrastructure Assessment and Climate Change Vulnerability Analysis [Element C]
10: Deerfield River Watershed Plan [Elements C, D, F, G, H, and I]
11: Issue Request for Responses for Consultant Services for Task 10.
12: Public Education and Outreach [Element E]
13: Climate Pilot Study for the Deerfield River Watershed

PROJECT COST: $305,971

FUNDING: $182,250 by the US EPA
$123,721 by the Franklin Regional Council of Governments

DURATION: 2015 – 2017

## C. Project Finances

Project Budget: The original project budget totaled $305,971, with $182,250 in EPA funds and $123,721 in match. The budget for this project was amended once to reflect changes in project needs and actual expenditures.

Match Documentation:

The original project budget included $123,721 in match, most of which ($121,521) was provided by the Massachusetts Department of Transportation (MassDOT) project - Climate Pilot Study for the Deerfield River Watershed. The purpose of this project was to develop risk-based and data driven protocols for assessing the present and future extreme flood vulnerability of roadway crossing structures within the Deerfield River Watershed. These protocols will incorporate consideration of a wide range of potential climatic change built and natural system stressors and risk factors- including present and future flood hydrologic conditions, geomorphic stability, ecological system accommodation, structural flood resilience, and transportation/emergency response service disruption impact. This project was undertaken by researchers and staff from UMass Amherst and funded by MassDOT. The project included the following tasks and available data from this work helped to inform the development of the Watershed-Based Plan:

- Conduct a vulnerability assessment for roads and road-stream crossings under present climate conditions affecting streamflow.
- Conduct a vulnerability assessment for roads and road-stream crossings under future climate conditions affecting streamflow.
- Integrate vulnerability factors due to future hydrologic and hydraulic conditions, geomorphic response, and aquatic stream continuity and fragmentation into a decision support tool that complements, supports, and augments present MassDOT system planning, project development, and bridge/culvert inspection processes.

Additional match was provided by the consultant team of Fuss & O'Neill and Field Geology Services. These firms provided $2,285 in additional uncompensated work towards the project. Total match for the project, $123,806, slightly exceeded the required match ($123,721).

**Attachment B**
**ORIGINAL Project Budget**
**A Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed**
**15-04/319**

| Expense Items | s.319 Amount | Non-Federal Match and Source | Total Amount |
|---|---|---|---|
| **Salary**<br>Planning & Development Director ($85-95/hr)<br>Land Use & Natural Resources Program Manager ($70-80/hr)<br>Chief Procurement Officer ($70-80/hour)<br>Land Use Planner ($50-60/hr)<br>Senior GIS Specialist ($60-70/hr)<br>Planning Assistant ($25-35/hr)<br>*Salary includes overhead rate of 125.54% | $102,750 | $2,200 (Dr. Cole, Task 6)<br>$2,400 (members of project working group Task 2)<br>$500 (volunteers, Task 7) | $107,850 |
| **Subcontractual Services**<br>Build Partnerships, Compile Baseline Data, Education and Outreach<br>Load Analysis, Comparative Subwatershed Analysis, Watershed Field Inventories<br>Deerfield Watershed Plan<br>Climate Pilot Study for the Deerfield River Watershed | <br>$10,000<br>$40,000<br>$25,000 | <br><br><br>$121,521 | $196,521 |
| **Materials and Supplies**<br>(including printing, mailing, final project report with photographs, and field supplies not to include equipment) | $4,000 | $0 | $4,000 |
| **Travel** (for auto mileage only @ $.45/mile) | $500 | $0 | $500 |
| **Other** | $0 | $0 | $0 |
| **Totals:** | **$182,250** | **$123,721** | **$305,971** |
| **Percent** | **%** | **%** | **100%** |

**Attachment B**
**REVISED Project Budget**
**June 30, 2017**
**A Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed**
**15-04/319**

| **Expense Items** | s.319 Amount | Non-Federal Match and Source | Total Amount |
|---|---|---|---|
| **Salary**<br>Planning & Development Director ($85-95/hr)<br>Land Use & Natural Resources Program Manager ($70-80/hr)<br>Chief Procurement Officer ($70-80/hour)<br>Land Use Planner ($50-60/hr)<br>Senior GIS Specialist ($60-70/hr)<br>Planning Assistant ($25-35/hr)<br>*Salary includes overhead rate of 125.54% | $127,020 | | $127,020 |
| **Subcontractual Services**<br>Build Partnerships, Compile Baseline Data, Education and Outreach<br>Load Analysis, Comparative Subwatershed Analysis, Watershed Field Inventories<br>Deerfield Watershed Plan<br>Climate Pilot Study for the Deerfield River Watershed | <br>$ 3,000<br>$49,000 | <br><br><br>$123, 721 | $175,721 |
| **Materials and Supplies**<br>(including printing, mailing, final project report with photographs, and field supplies not to include equipment) | $3,100 | $0 | $3,100 |
| **Travel** (for auto mileage only @ $.45/mile) | $130 | $0 | $130 |
| **Other** | $0 | $0 | $0 |
| **Totals:** | **$182,250** | **$123,721** | **$305,971** |
| **Percent** | **60%** | **40%** | **100%** |


**D. BMPs.**

No BMPs were installed as part of this project.

**E. Lessons Learned**

*Watershed Health*

Assessing the health of a watershed involves more than tallying up the number of impaired river segments on the Integrated List of Waters. Many of the issues identified in the Deerfield River Watershed can be addressed as part of a holistic watershed planning approach that recognizes that there are many types of impairments, even in a healthy watershed, and these impairments compromise the green infrastructure, climate change resiliency and overall health of the watershed and its resources. A holistic management approach also recognizes that the health and resiliency of the watershed directly affects the climate change resiliency of the municipal infrastructure, public safety and economic welfare of watershed residents. Maintaining the health and resiliency of the watershed's wetlands, floodplains, riparian corridors, forests and other vegetated open spaces will help to mitigate the impacts from severe storm events and flooding. These landscape-scale green infrastructure features also filter and recharge stormwater so groundwater and drinking water aquifers are replenished, which benefit watershed residents, and provide important aquatic and terrestrial habitat.

*Land Use Regulations*

Consistent land use regulations across the 14 watershed towns represent a largely untapped strategy for protecting the health of the Deerfield River Watershed. Massachusetts is a home rule state, where essentially all land use decisions and regulations are handled at the town level. In the Deerfield River Watershed communities, this is challenging because the decision-making is the responsibility of volunteer Planning Boards, Zoning Boards of Appeal, Boards of Health, and Conservation Commissions. These volunteers review development projects and propose amendments to town bylaws and regulations. Only one town in the Deerfield River Watershed has full-time professional staff assisting these boards – the Town of Greenfield. As Franklin County's largest community, Greenfield maintains a professional planning staff that assist the Town's volunteer boards with reviewing projects and amending regulations.

The recommendations developed by the Franklin Regional Council of Governments (FRCOG) for the Watershed-Based Plan were developed with a watershed scale as a backdrop. At a local level, the adoption of the recommendations will improve local conditions. If towns within a HUC 12 subwatershed adopt regulations and/or modify existing regulations to align with those of their neighboring towns in a subwatershed, then the scale of benefits and protections is enlarged. Over time, as towns improve their land use regulations across all 14 towns in the Deerfield River Watershed (HUC 8), the regulations will be more protective of the watershed's resources and enhance the resiliency of the watershed to climate change. FRCOG is available to help the watershed towns update

current land use regulations and adopt newer, cutting edge regulations, like a River Corridor Protection Overlay District.

*Implementation Projects for a Healthy Watershed*

The focus on land conservation as a river management tool is an effective way to spend limited funds while achieving the maximum return in terms of attenuating sediment load, enhancing instream and riparian habitat, mitigating flood inundation and fluvial erosion risks and building climate resiliency. The implementation projects identified for this Watershed-Based Plan are innovative and several focus on land conservation as a way to protect areas of high water quality and restore impaired areas. The implementation projects address three critical watershed issues: 1) protecting high quality Green Infrastructure; 2) restoring the river corridor and floodplains to reduce sediment loading and mitigate flooding; and 3) reducing sediment loading from mass failures and other unstable reaches of the HUC 12 tributaries.

Conceptual designs and cost estimates were prepared the implementation projects. Two projects will protect high quality upland watershed lands and tributaries and use wood additions to limit sediment transported out of the tributaries. Three potential projects were identified that can remove floodplain encroachments (berms), reconnect the river to its floodplain, and identify and protect lands in river corridors that could serve as "attenuation assets". This approach has been used successfully in Vermont. By preventing development of parcels that can serve as attenuation assets, meanders can reform in artificially straightened reaches and the river can be reconnected to its floodplain, which will provide sediment and flood attenuation along the HUC 12 tributaries. Two bank stabilization and sediment management projects were identified to improve water quality and restore impaired geomorphic function.

## F. Attachments

F1. Maps: A locus map showing watershed location of the project.

F2. Deliverables: The required project deliverables are listed, below, and included on the project CD.

**Task 1: Quality Assurance and Project Evaluation**
The project is covered under the Department's 319 Programmatic Quality Assurance Project Plan (QAPP), FFY 2011-2015, approved by US EPA on November 16, 2010, and will be covered under the revised QAPP for FFY 2016-2020 when approved by the US EPA. The Grantee or its designee will provide information as requested by the Department to facilitate evaluation and reporting of project success.

**Deliverable Task 1:**
1. Modeled results of anticipated pollutant load reductions achieved by BMPs implemented under this project, produced by the project designer, engineer, or other qualified person. Not applicable to this project. See Pollutant Loading Model Documentation - Appendix C of the Watershed-Based Plan for estimates of existing pollutant loads in the watershed. See separate CD.
2. Documentation of the BMP implementation work. Information to be supplied for each BMP includes BMP type, date of completed installation, targeted pollutant(s), size of targeted treatment area, and site maps. Not applicable to this project.

**Task 2: Build Partnerships**

**Deliverables Task 2:**

1. Facilitate up to 12 meetings of the plan development working group to review and comment on work to be completed under Tasks 4-12. A separate working group was not convened. Instead, FRCOG worked through existing stakeholder groups, including: Creating Resilient Communities; MA Fluvial Geomorphology Task Force; and Franklin Regional Planning Board. Stakeholder outreach is documented in the Appendix of the Watershed-Based Plan. See separate CD.
2. Agendas and minutes of the working group meetings. Not applicable.
3. Newspaper articles and web site postings to familiarize potential partners and stakeholders with the issues and outline the watershed planning process and encourage participation. Stakeholder outreach is documented in the Appendix of the Watershed-Based Plan. See separate CD.

**Task 3: Compile Baseline Watershed Conditions Data [Element A of a 319 Watershed-Based Plan]**

The objectives of this task are to gather existing data, create a watershed inventory, and identify data gaps. The Grantee will prepare an inventory and analysis of the baseline watershed conditions, including a general description of the watershed and the characteristics of its HUC 12 subwatersheds.

**Deliverables Task 3:**

1. Prepare a section of the watershed plan that describes the baseline watershed conditions for the categories listed above for the Deerfield River Watershed and for each of the HUC 12 watersheds. See Baseline Inventory of Watershed Conditions, Appendix A of the Watershed-Based Plan. See separate CD.
2. GIS Maps and tables for the Deerfield River Watershed and HUC 12 watersheds to illustrate baseline conditions for each category. See Baseline Inventory of Watershed Conditions, Appendix A and Subwatershed Plans in the Watershed-Based Plan. See separate CD.
3. Discussion of data gaps and methods and opportunities for collecting additional data. See Baseline Inventory of Watershed Conditions, Appendix A of the Watershed-Based Plan. See separate CD.

**Task 4: Issue Request for Responses (RFR) for Consultant Services for Tasks 5, 6, and 7**

Develop a RFR and select a qualified contractor for consulting services related to Task 5 Utilize the statewide WBP loading analysis; Task 6 Comparative Subwatershed Analysis; and Task 7 Watershed Field Inventories.

**Deliverables Task 4:**

1. A Request for Responses for consultant services. Completed. Fuss & O'Neill and Field Geology Services were selected to work with FRCOG.
2. A summary of proposals submitted to the Grantee with selection committee recommendations. Completed.

**Task 5: Estimate Pollutant Loads [Element A of a 319 Watershed-Based Plan]**

Utilize the statewide WBP pollutant loading analysis for the Deerfield River Watershed and its HUC 12 subwatersheds to guide the development of the watershed plan recommendations to quantify the anticipated load reductions associated with the recommendations, and identify healthy watershed areas

and guide the development of watershed plan recommendations for those areas.

Utilize the pollutant loading model to identify and rank pollutant sources, as well as assist in identifying, prioritizing, and evaluating subwatershed pollutant control strategies. Conduct additional modeling as necessary to fulfill project goals.

**Deliverables Task 5:**
1. Output from Model for the Deerfield River Watershed and HUC 12 watersheds. See Pollutant Loading Model Documentation, Appendix C of the Watershed-Based Plan. See separate CD.
2. Discussion and analysis of results. See Pollutant Loading Model Documentation, Appendix C of the Watershed-Based Plan. See separate CD.

**Task 6: Comparative Subwatershed Analysis**
This task will identify the most highly recoverable HUC 12 subwatersheds and the healthy HUC 12 subwatersheds with the greatest vulnerability to impairments. The MassDEP used the EPA's Recovery Potential Screening Tool (RPST) method to identify the 2015 Priority Waterbodies that are most likely to respond to remediation efforts that will result in meeting water quality standards.

Conduct a Comparative Subwatershed Analysis to identify the healthy HUC 12 subwatersheds with the greatest vulnerability and conservation potential. The results from the RPST and a list of subwatershed "metrics" will be used to conduct this analysis. Available GIS and other data would be used to compute the value of each metric. The results of this analysis will be used to prioritize field assessment efforts (Task 7) and to guide the development of watershed plan recommendations. The analysis involves a screening level evaluation of selected subwatershed metrics that are derived by analyzing available GIS layers and other subwatershed data sources. Subwatersheds with higher aggregate "vulnerability" scores are more sensitive to future development and should be the focus of watershed conservation efforts to maintain existing high-quality resources and conditions.

**Deliverables Task 6:**
1. Discussion and summary of HUC 12 subwatershed vulnerability metrics. See HUC 12 Subwatershed Plans and Watershed Assessments, Appendix B. of the Watershed-Based Plan. See separate CD.
2. A list and discussion of priority healthy HUC 12 subwatersheds for conservation. See See HUC 12 Subwatershed Plans and Watershed Assessments, Appendix B. of the Watershed-Based Plan. See separate CD.

**Task 7: Watershed Field Inventories [Elements A and C of a 319 Watershed-Based Plan]**
The objective of this task is to identify conservation/restoration opportunities in selected stream corridors and upland areas within the priority healthy subwatersheds, which were identified in Task 6, and to identify restoration and resiliency opportunities in selected stream corridors and upland areas within the impaired segments identified by MassDEP and the RPST.

**Deliverables Task 7:**
1. Completed field inventory logs and photo-documentation for each assessed stream corridor segment. See discussion in Watershed-Based Plan, HUC 12 Subwatershed Plans, and Project Conceptual

Designs/Cost Estimates, Appendix G of the Watershed-Based Plan. See separate CD.
2. Summary of findings by priority subwatershed. See discussion in Watershed-Based Plan, HUC 12 Subwatershed Plans, and Project Conceptual Designs/Cost Estimates, Appendix G of the Watershed-Based Plan. See separate CD.
3. Discussion of appropriate conservation and restoration strategies for each priority subwatershed. See discussion in Watershed-Based Plan, HUC 12 Subwatershed Plans, and Project Conceptual Designs/Cost Estimates, Appendix G of the Watershed-Based Plan. See separate CD.
4. Site-specific concept designs and cost estimates. See discussion in Watershed-Based Plan, HUC 12 Subwatershed Plans, and Project Conceptual Designs/Cost Estimates, Appendix G of the Watershed-Based Plan. See separate CD.

**Task 8: Land Use Regulatory Review [Element C of a 319 Watershed-Based Plan]**
This task will identify gaps in local land use regulations and make recommendations that will protect the healthy subwatersheds.

**Deliverables Task 8:**
1. A summary and discussion of existing land use regulations for the watershed communities. See Regulatory Review, Appendix D of the Watershed-Based Plan. See separate CD.
2. Recommendations to strengthen town regulations and encourage consistency among the watershed towns. See HUC 12 Subwatershed Plans. See separate CD.
3. A presentation to the Franklin Regional Planning Board. See Appendix H. of the Watershed-Based Plan. See separate CD.

**Task 9: Green Infrastructure Assessment and Climate Change Vulnerability Analysis [Element C of a 319 Watershed-Based Plan]**
This task will inventory and map the watershed's green infrastructure, assess the vulnerability of the Deerfield River Watershed to climate change and other threats, and develop recommendations for preserving the green infrastructure and resiliency of a healthy watershed.

**Deliverables Task 9:**
1. GIS maps of the green infrastructure of the Deerfield Watershed and each of the HUC 12 subwatersheds. See Green Infrastructure Analysis, Appendix E. of the Watershed-Based Plan and the HUC 12 Subwatershed Plans. See also Appendix A. Baseline Inventory and the Watershed-Based Plan. See separate CD.
2. A discussion of threats and vulnerabilities of the green infrastructure to climate change. See the HUC 12 Subwatershed Plans and the Watershed-Based Plan. See separate CD.
3. A discussion of recommendations and tools for protecting the green infrastructure on a watershed and HUC 12 subwatershed scale. See the HUC 12 Subwatershed Plans and the Watershed-Based Plan. See separate CD.

**Task 10: Deerfield River Watershed Plan [Elements C, D, F, G, H, and I of a 319 Watershed-Based Plan]**
This task will provide a comprehensive Deerfield River Watershed Plan that uses the systems-based approach of the EPA's Healthy Watersheds Initiative and meets the 9 elements of a Watershed-Based Plan under the 319 program.

**Deliverables Task 10:**

1. Watershed Plan for the Deerfield River that uses the systems-based approach of the EPA's Healthy Watersheds Initiative and meets the 9 elements of a Watershed-Based Plan under the 319 program. See the complete Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed. See separate CD.
2. Conceptual designs and cost estimates for selected site-specific projects that would be potential implementation projects. See Appendix G of the complete Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed. See separate CD.
3. Anticipated pollutant load reductions for the plan recommendations for which pollutant loads can be reasonably quantified. Load reductions would be summarized by HUC 12 subwatershed and for the Deerfield River Watershed. This task was not completed due to the types of Healthy Watershed recommendations and conceptual designs selected for the Deerfield River Watershed.
4. Targeted recommendations to address issues within specific subwatersheds or areas to address common types of problems that were identified at representative locations throughout the watershed. See the complete Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed. See separate CD.
5. Watershed-wide recommendations that could be implemented in each of the watershed towns and are intended to address nonpoint source pollution through municipal land use regulations, green infrastructure protection/restoration, public education and outreach, open space protection, and watershed monitoring. See the complete Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed. See separate CD.
6. Interactive web-based version of the plan. This task was not completed following discussions with MassDEP and the ongoing development of the state-wide web-based Watershed-Based Plan development tool.

**Task 11: Issue Request for Responses (RFR) for Consultant Services for Task 10.**

Engage a qualified consultant to assist with the development and launch of a web-based version of the watershed plan. Develop a RFR and select a qualified contractor for consulting services related to developing a web site and interactive web-based version of the watershed plan (Task 10).

**Deliverables for Task 11:**

1. A Request for Responses for consultant services. This task was not completed following discussions with MassDEP and the ongoing development of the state-wide web-based Watershed-Based Plan development tool.
2. A summary of proposals submitted with selection committee recommendations. See above.

**Task 12: Public Education and Outreach. [Element E of a 319 Watershed-Based Plan]**

**Deliverables Task 12:**

1. A Public Education and Outreach Program. See the complete Watershed-Based Plan and Appendix H. Public Participation. See separate CD.
2. Pre- and post-outreach surveys and summary of survey results. One survey was done and an interactive workshop for local officials. See the complete Watershed-Based Plan and Appendix H. Public Participation. See separate CD.
3. Presentation materials for a project kick-off meeting and to present the watershed plan. Both presentations will be given to three groups for a total of six meetings. Two presentations were given.

See the complete Watershed-Based Plan and Appendix H. Public Participation. See separate CD.

**Task 13: Climate Pilot Study for the Deerfield River Watershed**

This project was funded by MassDOT. Work was done by UMass-Amherst, Trout Unlimited and Milone & MacBroom. The project has not been completed and no deliverables are available to the public. MassDOT did make some data available to inform the development of the Watershed-Based Plan, HUC 12 Subwatershed plans, and their recommendations. See attached CD.

**Deliverables Task 13:**

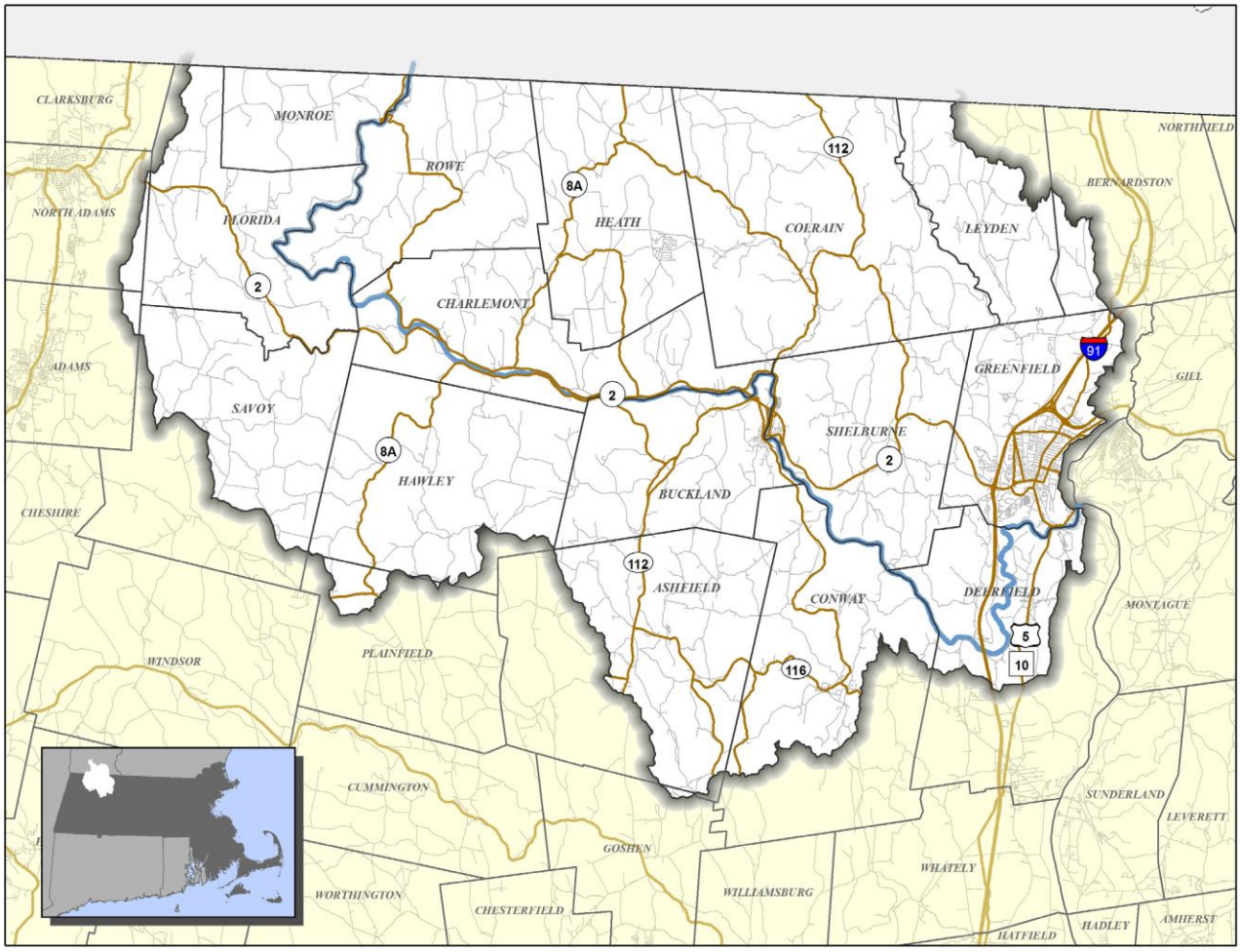
1. Culvert As-Built Design Flows: determine the design flow capacity of the 842 road-stream crossings within the Deerfield Watershed, focusing on culverts. Still under development.
2. Assessment of Current Vulnerability Due to Extreme Flows: determine the precipitation and flow data under which the culvert design flow is exceeded, and use this to categorize the culverts into low, medium, and high vulnerability. Still under development.
3. Future Climate Assessment: prepare a vulnerability assessment for road-stream crossings due to future extreme flows. Still under development.

**Task 14: Reporting and Project Oversight**

**Deliverables Task 14:**

1. Quarterly Progress Reports and Billing. Completed.
2. Final Project Report. Completed.

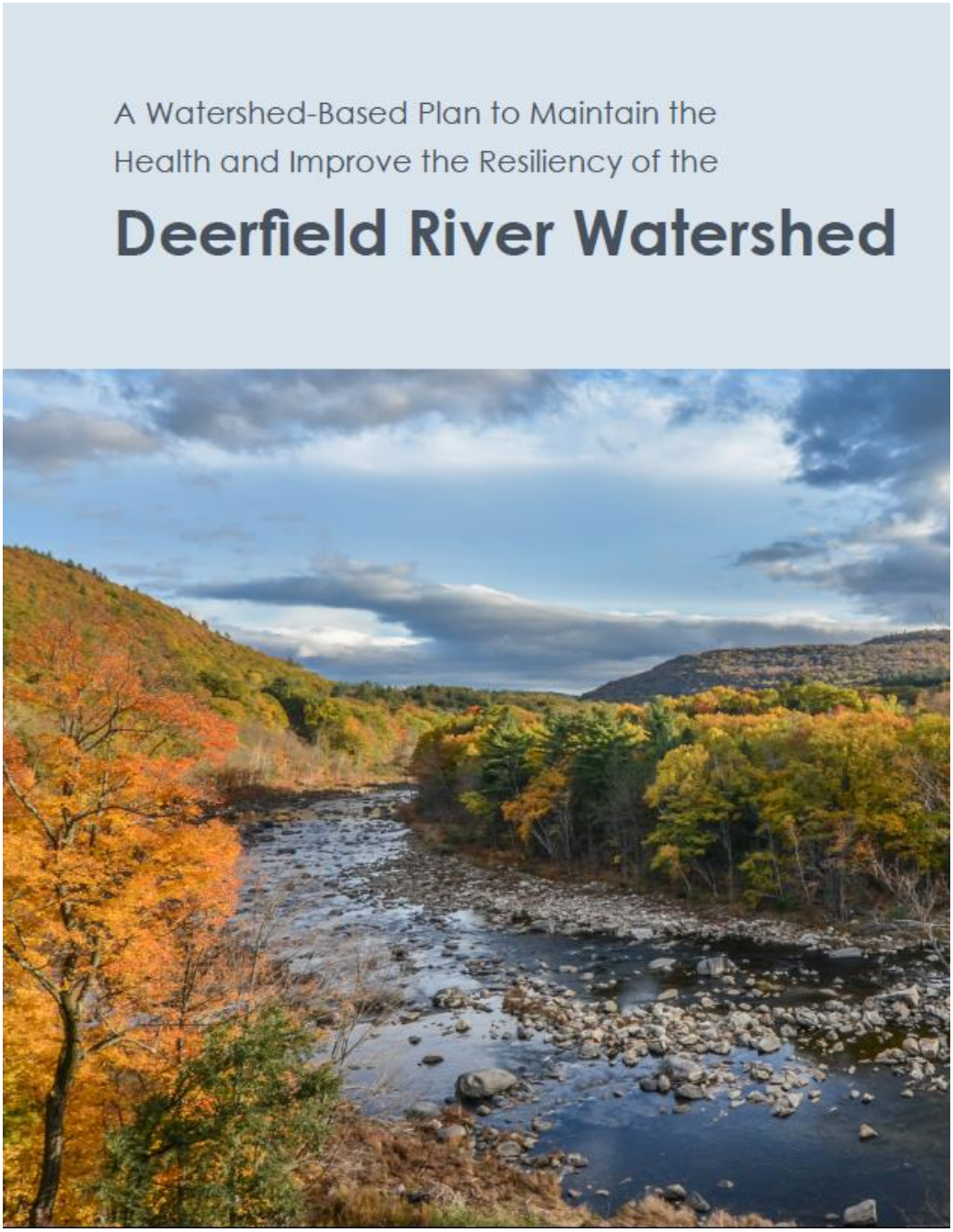
# F. ATTACHMENTS




**Locus map of the Deerfield River Watershed (HUC 8)**

# DELIVERABLES

*Attached CD contains the complete Watershed-Based Plan.*
*Conceptual designs for Healthy Watershed Projects are included on the CD and here.*



# Conceptual Designs and Cost Estimates for Healthy Watershed Projects

Note that cost estimates for land conservation are complex, and those included in this document are provided for guidance, and should not be relied upon for the further development of a budget for implementation. Continued outreach, local support and landowner buy-in are crucial to the actualization and success of these proposed projects. For background information on these project designs see Geomorphic Assessment Technical Memorandum in Appendix B. Watershed Assessments.

## Lower Bear River Conservation Area

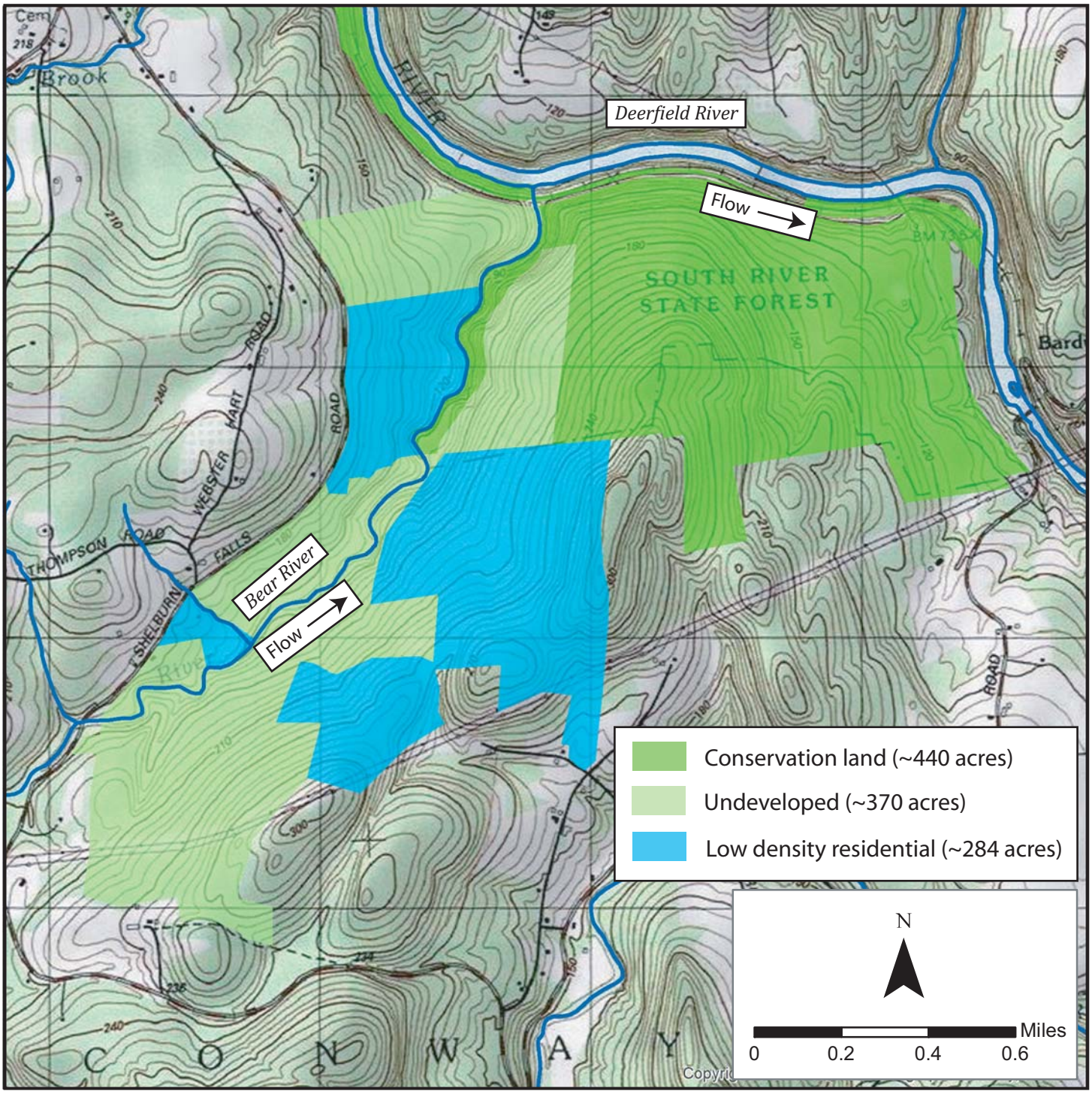
Project Benefits: Sediment Storage, Flood Attenuation, and Conservation of Green Infrastructure.

Project Description: Conservation of reference reach area on lower Bear River.

The permanent protection of 500-plus contiguous acres adjacent to the South River State Forest in Conway. These lands, which include both banks of the lower two miles of the Bear River down to its confluence with the Deerfield River, contain a mix of pristine forested habitats including previously identified rare and endangered plant species. The steep, confined stream channel ranges from cobble riffle-pool, to boulder step-pool and bedrock cascade morphologies and represents a relatively natural reference condition with little evidence of past human manipulation. As envisioned this project should rank highly for a competitive Land Partnership Grant. Land acquisition costs for this project, included in the following pages, are based on the assessed land values from the Town's tax assessment. From these values, the median value per acre for the undeveloped parcels was calculated ($1500 per acre). An additional $1000 per acre was added for residential parcels (based on a breakdown of increases in value in the data set).

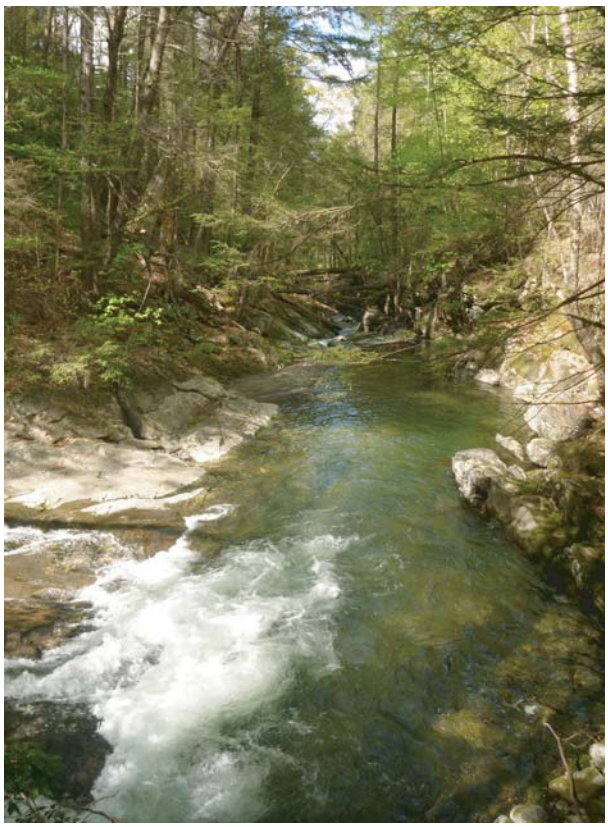
Estimate of probable costs:

| Treatment/Item | Unit | Quantity | Unit Cost ($) | Task Cost ($) |
|---|---|---|---|---|
| Land acquisition - undeveloped land | acre | 370 | $1,500.00 | $555,000.00 |
| Land acquisition - residential land | acre | 284 | $2,500.00 | $710,000.00 |
| Parking area construction<br>includes grading, gravel lot, interpretive signs, etc | unit | 1 | $35,000.00 | $35,000.00 |
| Clear and establish walking trails | mile | 2 | $15,000.00 | $30,000.00 |
| Site upkeep and trail maintenance | year | 5 | $5,000.00 | $25,000.00 |
| TREATMENT SUBTOTAL | | | | $1,355,000.00 |
| 20% Contingency | | | | $271,000.00 |
| **Construction subtotal** | | | | **$1,626,000.00** |
| Surveying, permitting and legal costs | | | | $100,000.00 |
| Project total | | | | $1,726,000.00 |

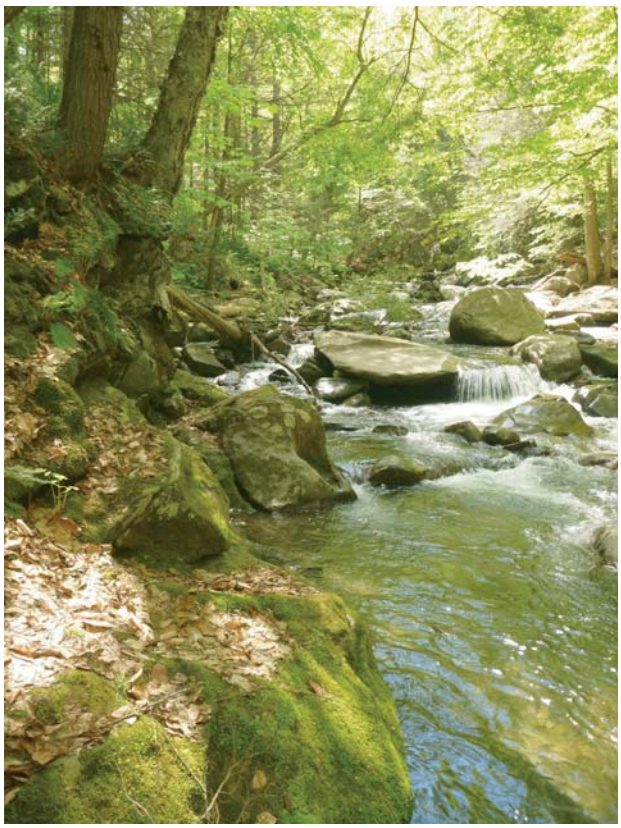



Lower Bear River Conservation Area - site map.

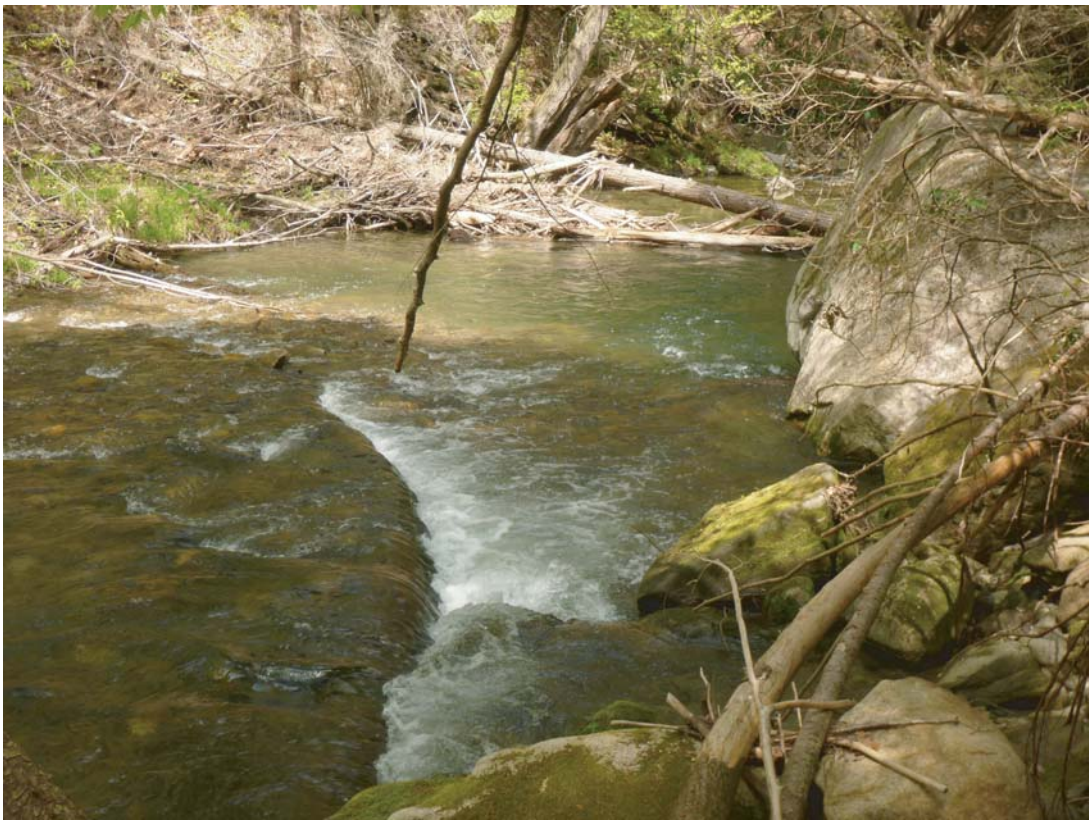
a)



b)



c)



Lower Bear River Conservation Area. The a) bedrock cascade, b) boulder step-pool, and c) cobble riffle-pool stream morphologies of the lower Bear River represent a relatively natural reference condition with little evidence of past human manipulation.

a)


b)

Lower Bear River Conservation Area. a) Public access to the stream and surrounding land adjacent to South River State Forest is part of the proposed conservation; b) channel-spanning log jam maintaining deep pool and providing cover in this cold water fishery.

## Upper Bear River Conservation and Geomorphic Restoration

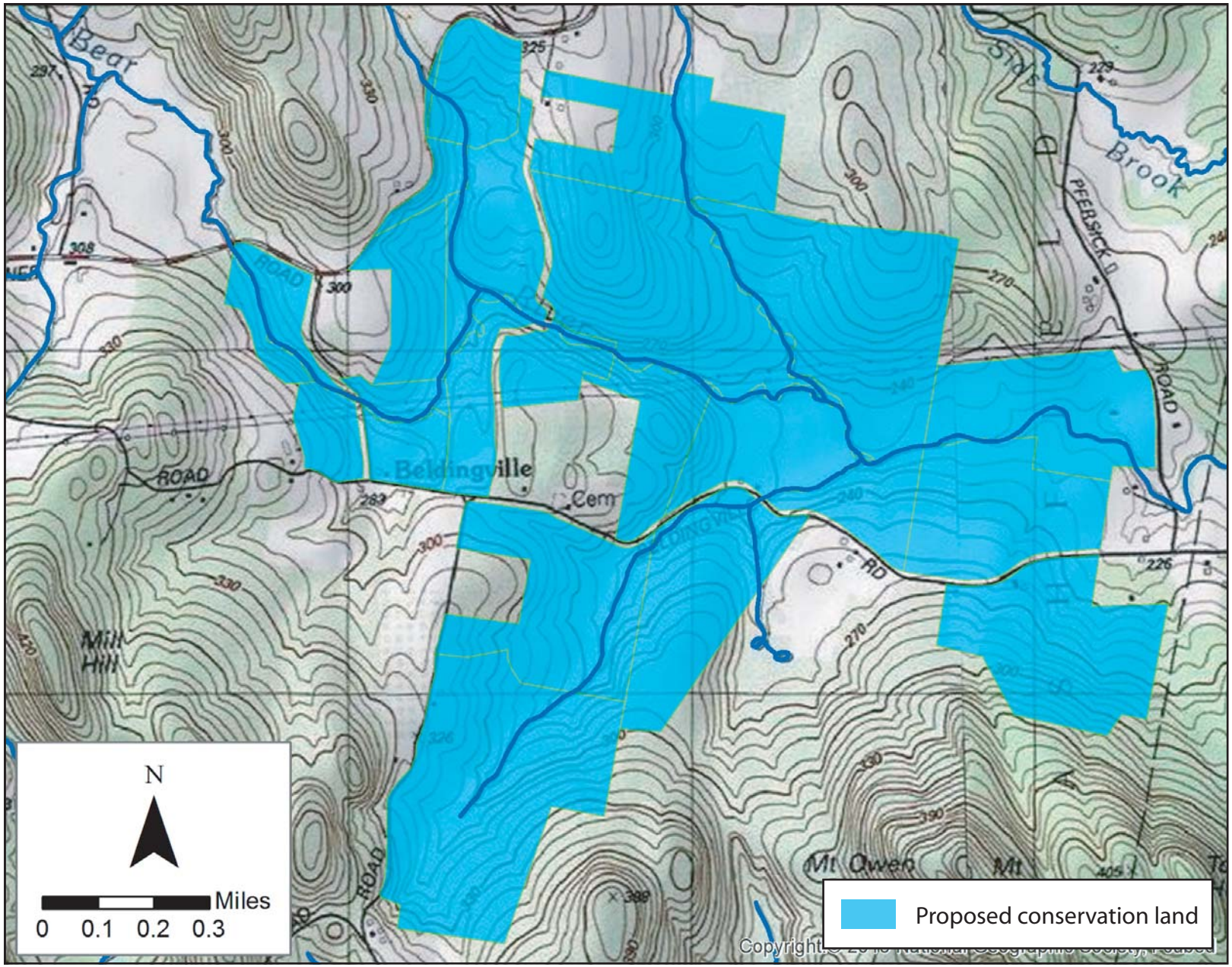
Project Benefits: Sediment Storage, Flood Attenuation, Habitat Enhancement and Conservation of Green Infrastructure.

Project Description: Conservation and geomorphic restoration (wood addition) on upper Bear River.

Using the Franklin Land Trust's Crowningshield Conservation Area as a model for conservation paired with geomorphically-compatible stream restoration and management, this project seeks to protect a 200-foot wide river corridor through portions of the upper Bear River. As with the Crowningshield project, these predominantly forested parcels contain historically-altered stream channels in the upper portions of the watershed where wood addition projects have been shown to effectively trap sediment, depress flood peaks, increase base flow and enhance habitat. The proposed "chop and drop" treatment, where trees are strategically cut from the riparian zone and directionally-felled into and across the stream channel, has had a great deal of success in forested reaches throughout New England. The design calls for the addition of a minimum of 200 pieces of large wood per mile through chop and drop, although wood-loading density could be increased if desired. Additionally, marginal log jams and/or instream engineered log structures to be constructed with trees sourced from the river corridor will provide additional sediment storage and habitat benefits. Several of these structures could be built with the intention of recruiting any wood mobilized from the chop and drop reaches upstream. Monitoring, included as part of this project, will consist of tracking and mapping the recruitment and movement of wood through the stream system and measuring its effects on pool depth, channel dimensions, substrate composition, temperature profiles, and invertebrate and fish populations. Water stage and turbidity monitoring, an analogue for suspended sediment load, will attempt to assess the influence of wood addition on suspended sediment load. These studies have the potential to demonstrate the benefits of wood addition projects to trap sediment and enhance habitat.

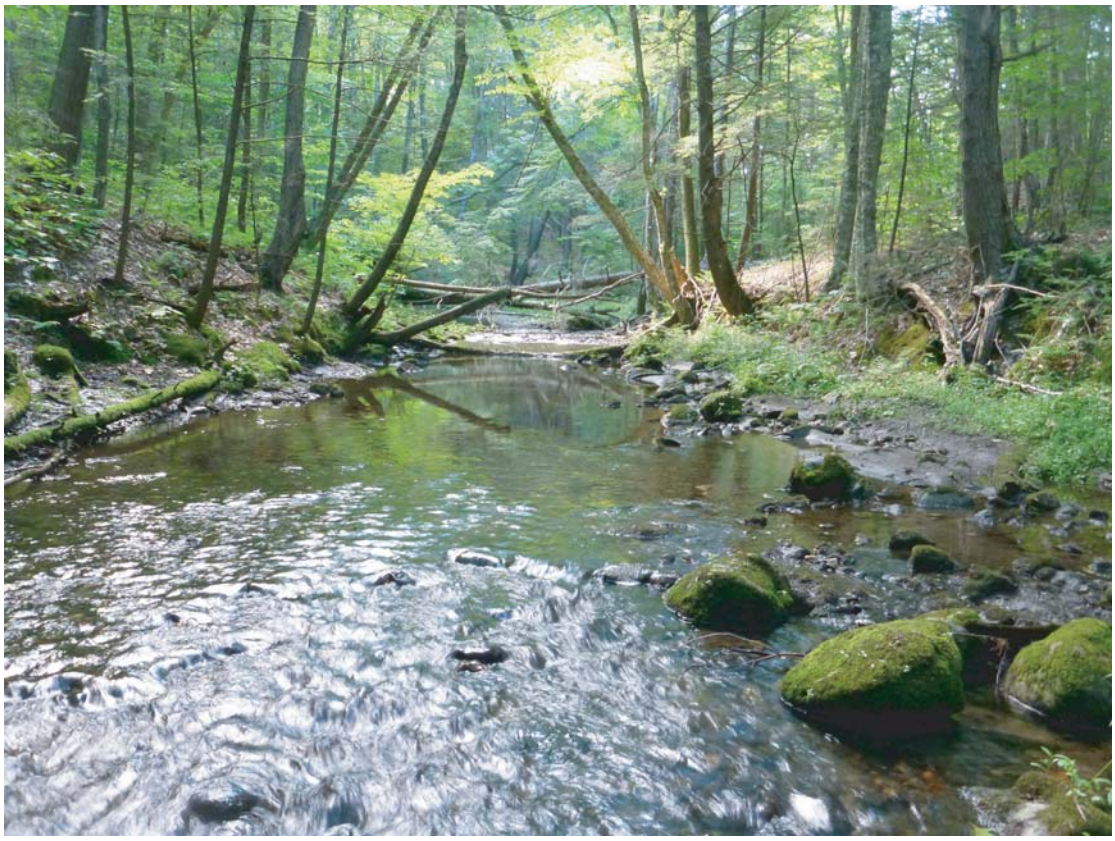
## Estimate of probable costs:

| Treatment/Item | Unit | Quantity | Unit Cost ($) | Task Cost ($) |
|---|---|---|---|---|
| Corridor easement (200 feet wide) | acre | 109 | $1,500.00 | $163,500.00 |
| Chop and drop wood addition (200 pieces per mile) | mile | 2 | $15,000.00 | $30,000.00 |
| Marginal log jam / engineered log structures | EA | 8 | $2,500.00 | $20,000.00 |
| Machinery | day | 3 | $4,000.00 | $12,000.00 |
| Construction Oversight | day | 3 | $1,680.00 | $5,040.00 |
| Pre and Post-implementation monitoring: Monumented surveying and photo logs, fish and invertebrate surveys, water stage, turbidity, pebble counts, temperature profiles, tracking wood mobility | year | 5 | $7,500.00 | $37,500.00 |
| TREATMENT SUBTOTAL | | | | $268,040.00 |
| 20% Contingency | | | | $53,608.00 |
| **Construction subtotal** | | | | **$321,648.00** |
| Surveying, permitting and legal costs | | | | $70,000.00 |
| Project total | | | | $391,648.00 |




Upper Bear River conservation and geomorphic restoration - site map.

a)



b)

Upper Bear River conservation and geomorphic restoration. a) Artificially straightened channels in the upper Bear River are appropriate targets for conservation and restoration through wood addition, where b) naturally recruited wood can be seen storing sediment.

a)

b)

Upper Bear River conservation and geomorphic restoration. The proposed design includes a) Chop and drop wood additions (photo from Griffith Brook, Green Mountain National Forest, VT) and b) marginal log jams (photo from Nash Stream, NH).

## Conservation of Attenuation Assets and Encroachment Removal

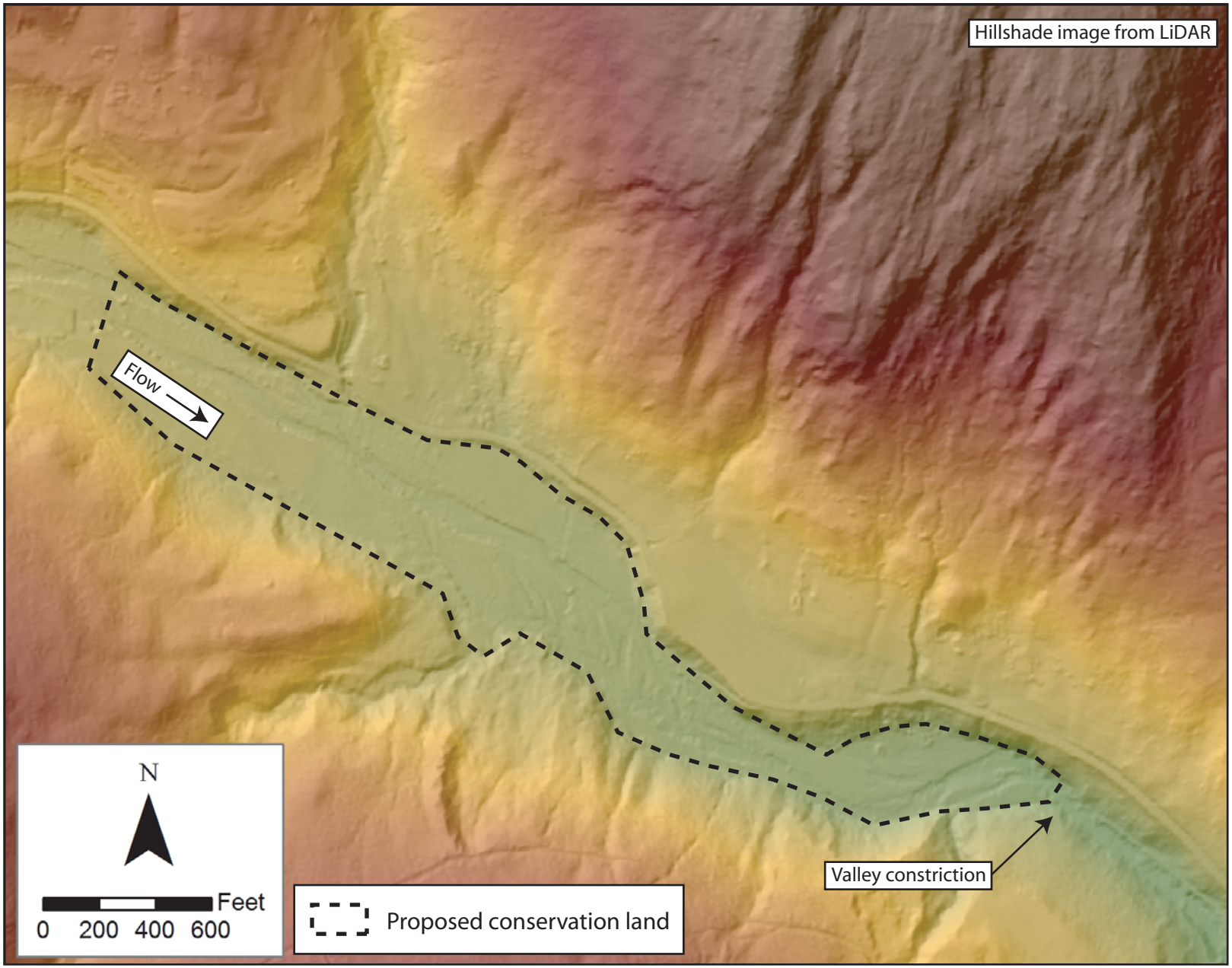
Project Benefits: Sediment Storage, Removal of Floodplain Encroachments (berms), Riparian Corridor Improvements, Floodplain Reconnection and Flood Water Attenuation, Habitat and Water Quality Enhancements, and Protection of Regionally Significant Infrastructure.

Project Description: Identification and enhancement/conservation of attenuation assets through berm removal, floodplain reconnection, corridor easements and corridor management strategies. Potential sites in three HUC 12 subwatersheds: North River Mainstem (West Branch North River); South River; and Green River.

The Geomorphic Assessment identified potential attenuation assets along North River Mainstem (West Branch North River), South River, and in the Green River Watershed. Along the West Branch North River many agricultural parcels sustained flood or erosion damage during Tropical Storm Irene. Several parcels have been identified for conservation in this dynamic alluvial fan setting in order to attenuate sediment load and build climate resiliency. Along South River, low-value parcels without the necessary frontage for development, have been identified along the artificially straightened stream channel. The South River is observed to be increasing its sinuosity by re-forming meanders in these reaches. The proposed conservation would encourage meanders to re-form and increase sediment storage on the floodplain and within the reach. Hinsdale Brook, a tributary to Green River, flows through a steep confined valley dominated by exposures of compacted glacial till and bedrock. The extensive mass failures along Hinsdale Brook contribute a large volume of sediment to the Green River as sediment is transported down the straightened channel. Above the confluence with Green River, continued development threatens to increase fluvial erosion hazards in this flood-prone corridor. Conservation of these parcels through acquisition or easements have significant potential benefits to downstream reaches in the form of sediment and flood water attenuation.

## Estimate of probable costs (per site):

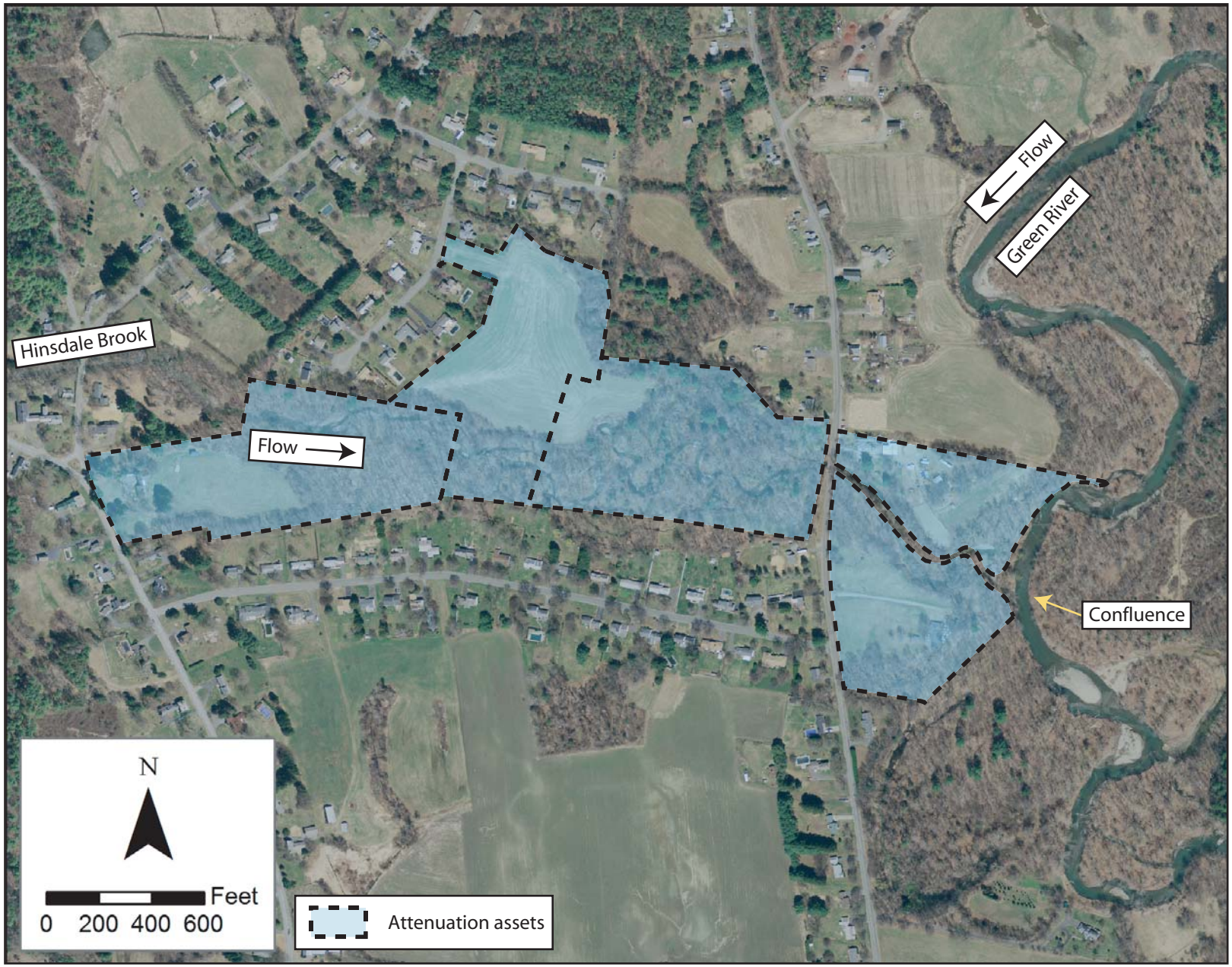
| Treatment/Item | Unit | Quantity | Unit Cost ($) | Task Cost ($) |
|---|---|---|---|---|
| Land acquisition / corridor easement | acre | 50 | $1,500.00 | $75,000.00 |
| Berm removal | unit | 1 | $20,000.00 | $20,000.00 |
| Bank cutting / flow diversion | unit | 1 | $10,000.00 | $10,000.00 |
| Machinery | day | 3 | $4,000.00 | $12,000.00 |
| Construction Oversight | day | 3 | $1,680.00 | $5,040.00 |
| TREATMENT SUBTOTAL | | | | $122,040.00 |
| 20% Contingency | | | | $24,408.00 |
| **Construction subtotal** | | | | **$146,448.00** |
| Surveying, permitting and legal costs | | | | $70,000.00 |
| Project total | | | | $216,448.00 |




Conservation of attenuation assets and encroachment removal - West Branch North River site map.


Conservation of attenuation assets and encroachment removal - West Branch North River. 2014 aerial photo showing flood-damaged riparian lands and extent of agricultural use prior to Tropical Storm Irene.


Conservation of attenuation assets and encroachment removal - South River. 2014 aerial photo showing identified attenuation asset along South River in Conway, MA. Significant bank erosion observed on agricultural parcel as meanders reform along straigntened channel.



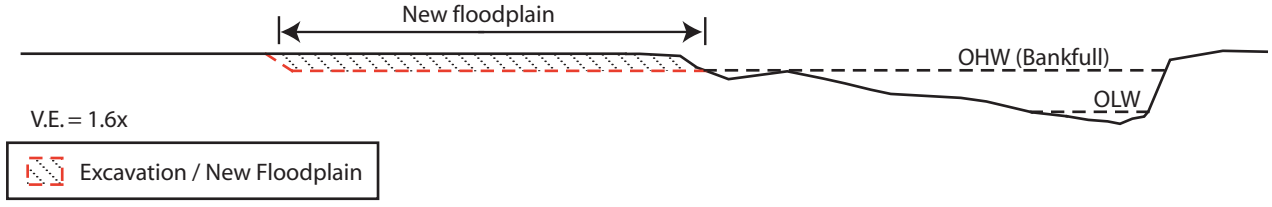

Conservation of attenuation assets and encroachment removal - Green River Watershed. Identified attenuation assets along lower Hinsdale Brook upstream of Green River confluence in Greenfield, MA. Continued development along straightened channel threatens to increase fluvial erosion hazards in stream corridor.

a)

b)

c)


d)




Conservation of attenuation assets and encroachment removal - Example photos showing a) berm removal on West Branch North River, b) extent of floodplain lowering on South River, c) loading sediment for transport off site (South River), and d) topographic design survey of cross section of lowered floodplain (South River).

## Lower Clesson Brook

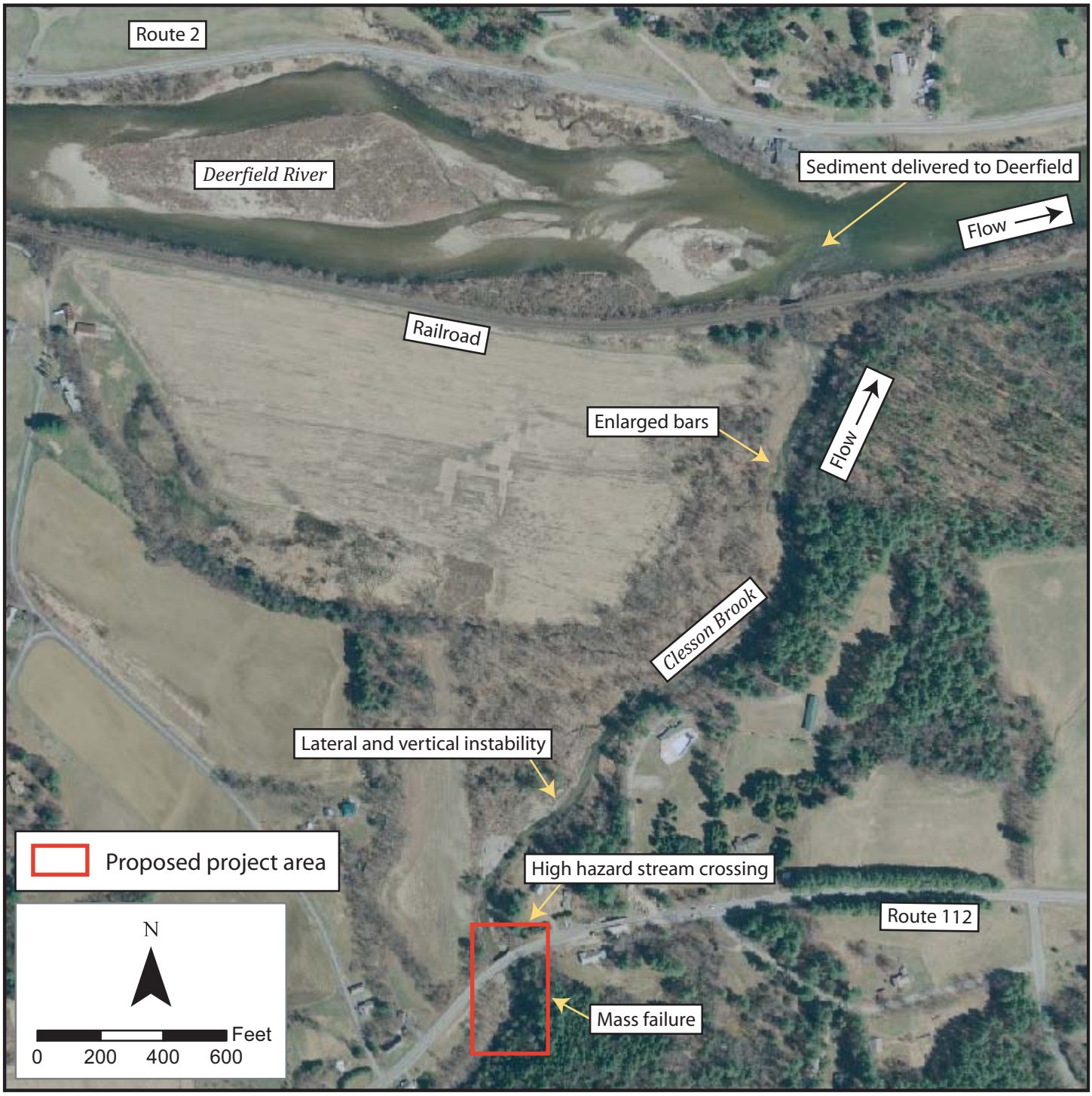
Project Benefits: Sediment Storage, Removal of Floodplain Encroachments (berms), Riparian Corridor Improvements, Floodplain Reconnection and Flood Water Attenuation, Habitat and Water Quality Enhancements, and Protection of Regionally Significant Infrastructure.

Project Description: Stabilization of mass failure on Clesson Brook to protect Rte. 112 bridge and limit sediment delivery to Clesson Brook delta, which has formed in the Deerfield River.

A 38-feet high mass failure (landslide in glacial deposits) immediately upstream of the Route 112 stream crossing threatens the bridge and contributes a significant volume of sediment to Clesson Brook. Sediment from Clesson Brook and other tributaries deposited in the Deerfield River contributes to the formation of large gravel bars and represents increased hazards to bridges, roads and other infrastructure. The proposed project includes the construction of a 150-foot long bankfull bench along the base of the eroding glacial bank. Five boulder deflectors will extend out from the front of the bench, which will also be lined with whole trees and woody material, increasing roughness and providing cover habitat. A similar technique was employed on South River in Conway in 2016. This design is intended to stabilize the glacial bank, which will be sloped, graded and seeded/planted with vegetation, thereby limiting sediment delivery to Clesson Brook and the Deerfield River.

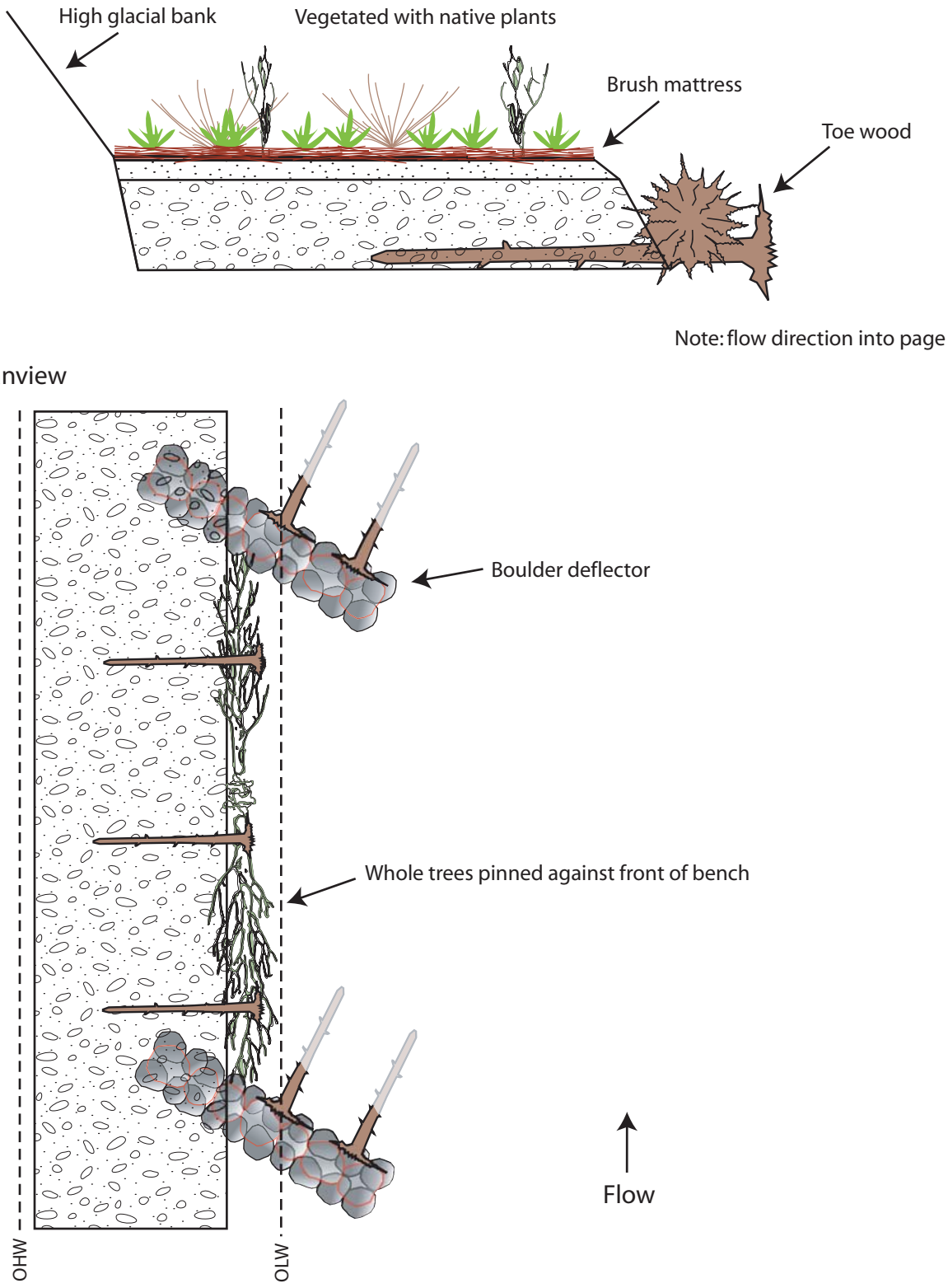
Estimate of probable costs:

| Treatment/Item | Unit | Quantity | Unit Cost ($) | Task Cost ($) |
|---|---|---|---|---|
| Constructed bankfull bench | linear ft | 150 | $115.00 | $17,250.00 |
| Boulder deflectors | EA | 5 | $6,000.00 | $30,000.00 |
| Bank sloping / establish vegetation | unit | 1 | $12,000.00 | $12,000.00 |
| Machinery | day | 5 | $4,000.00 | $20,000.00 |
| Construction oversight | day | 5 | $1,680.00 | $8,400.00 |
| On-going sediment removal to maintain bridge | year | 5 | $10,000.00 | $50,000.00 |
| | | | | |
| TREATMENT SUBTOTAL | | | | $137,650.00 |
| 20% Contingency | | | | $27,530.00 |
| **Construction subtotal** | | | | **$165,180.00** |
| | | | | |
| Permitting costs | | | | $70,000.00 |
| | | | | |
| Project total | | | | $235,180.00 |




Lower Clesson Brook - area map.

Lower Clesson Brook - photo of mass failure just upstream of Route 112 crossing on lower Clesson Brook.




Lower Clesson Brook - constructed bankfull bench design typical.

## North River Mainstem Sediment Management Project

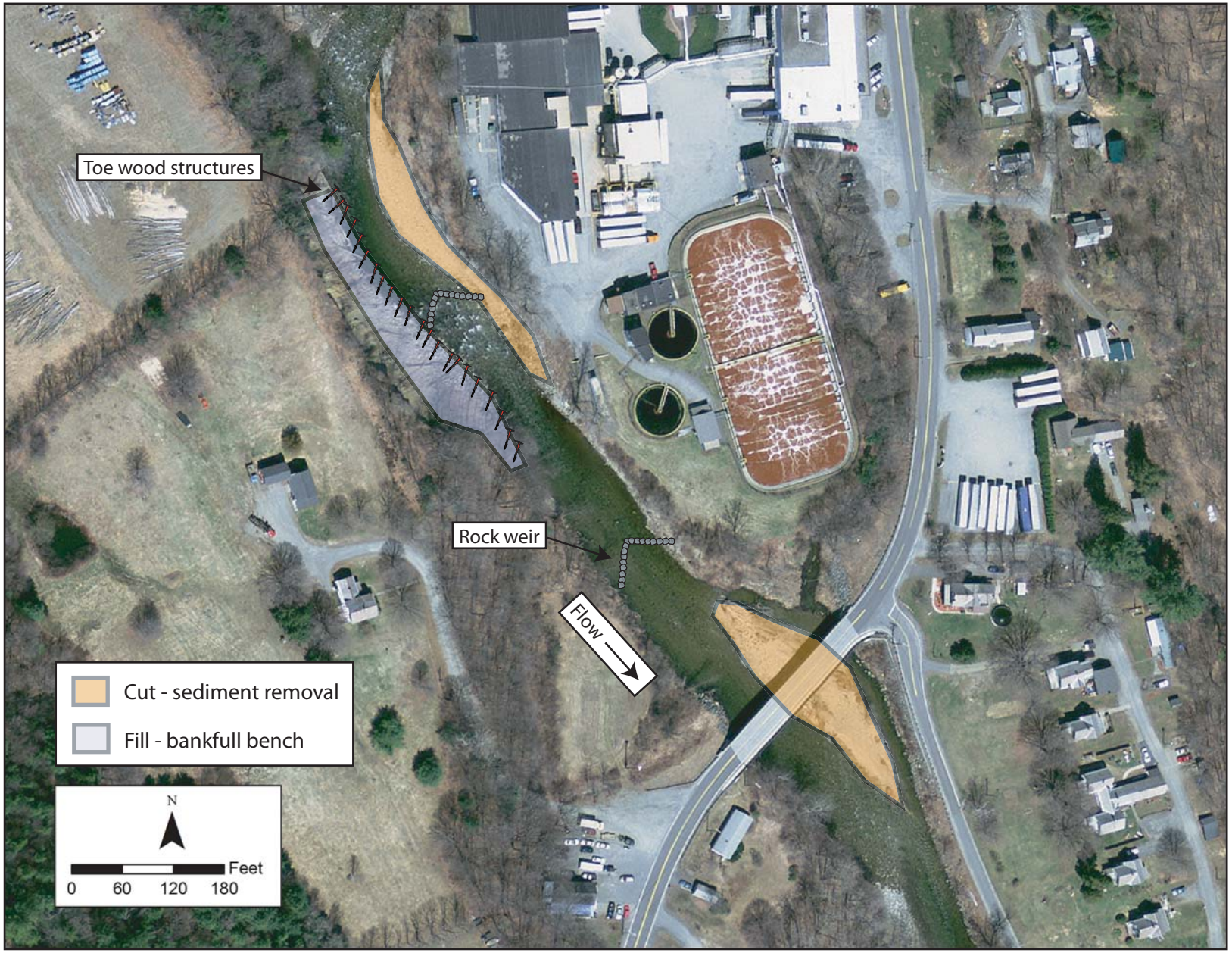
Project Benefits: Sediment Storage, Removal of Floodplain Encroachments (berms), Riparian Corridor Improvements, Floodplain Reconnection and Flood Water Attenuation, Habitat and Water Quality Enhancements, and Protection of Regionally Significant Infrastructure

Project Description: North River Mainstem sediment management project. Includes removal of excess sediment in and around the piers of the new Rte. 112 bridge and using the sediment to stabilize upstream mass failure adjacent to Barnhardt Manufacturing.

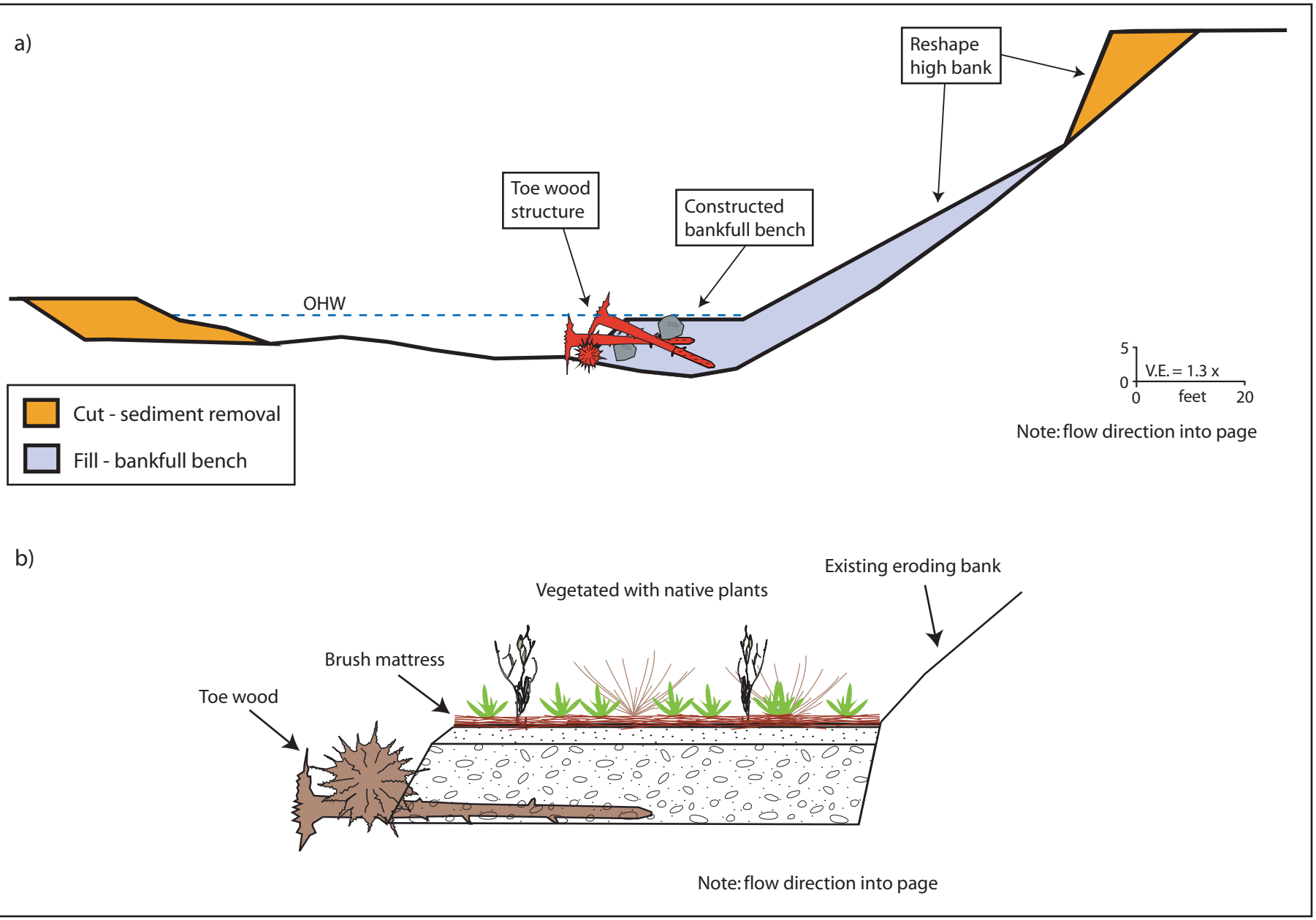
Excess sediment, sourced in part from a 50-foot high mass failure opposite the Barnhardt Manufacturing plant on the North River Mainstem is accumulating around the center pier of the Route 112 bridge. The increased scour at the abutments threatens to undermine this bridge, which Mass DOT replaced in 2005. The proposed design calls for removal of sediment from the area around the bridge's center pier and the establishment of a sediment management plan. As envisioned, this management plan would consist of an open permit or order with State, Federal and local officials allowing for sediment removal in and around the structure, under the supervision of a qualified fluvial geomorphologist, to maintain the safety and integrity of the stream crossing. No sediment would be removed from the stream channel during initial project implementation; rather this sediment would be used in the construction of a bankfull bench along the 450-foot long mass failure upstream. In a design similar to that proposed for the stabilization of the mass failure on lower Clesson Brook, a roughened and vegetated bankfull bench would be used to stabilize the high glacial bank by deflecting flow away from its base. Two channel-spanning porous rock weirs are included in the design to further deflect flow towards the center of the channel. These structures will improve the bridge's capacity by lining up the channel thalweg with the bridge openings and limiting gravel deposition around the center pier.

## Estimate of probable costs:

| Treatment/Item | Unit | Quantity | Unit Cost ($) | Task Cost ($) |
|---|---|---|---|---|
| Porous rock weirs | EA | 2 | $27,500.00 | $55,000.00 |
| Constructed bankfull bench | linear ft | 450 | $115.00 | $51,750.00 |
| Toe wood structures | EA | 25 | $3,750.00 | $93,750.00 |
| Machinery | day | 10 | $4,000.00 | $40,000.00 |
| Construction oversight | day | 10 | $1,680.00 | $16,800.00 |
| On-going sediment removal to maintain bridge | year | 5 | $10,000.00 | $50,000.00 |
| | | | | |
| TREATMENT SUBTOTAL | | | | $307,300.00 |
| 20% Contingency | | | | $61,460.00 |
| **Construction subtotal** | | | | **$368,760.00** |
| | | | | |
| Permitting costs | | | | $70,000.00 |
| | | | | |
| Project total | | | | $438,760.00 |




North River Mainstem Sediment Management Project - proposed planview.




North River Mainstem Sediment Management Project - constructed bankfull bench typical as a) surveyed channel cross section and b) close-up schematic.

a)

b)

North River Mainstem Sediment Management Project - Photos of a) 50-foot high mass failure opposite the Barnhardt Manufacturing plant on North River Mainstem and b) sediment accumulating around the center pier of the Route 112 bridge.